XXVI.—*Second Communication on the Vasa Propria, Laticiferous Vessels, &c., of Plants.* By M. T. Lestiboudois*.

This second communication by M. Lestiboudois was made to the Academy of Sciences in April last, and forms a continuation of the memoir previously presented to that learned body, of which a translation appeared in the 'Annals' for June last (vol. xi. p. 402).

We have established (writes M. Lestiboudois) beyond doubt the existence, in certain plants, of vessels containing coloured liquids.

It has indeed been held that such vessels are primitively nothing more than passages or interspaces, permeated by a thread of granuliferous fluid, and that the formation of a wall to limit them as vessels is a subsequent event. But what does this signify? Are there not cells whose walls are only developed subsequently to the nucleus? and such cells are as perfectly characterized as others. If therefore these vasa propria have such delicate walls as can only be detected at a later period of their existence, they nevertheless constitute a vascular system distinguished by the characters heretofore described. In this we have an established scientific fact.

However, it must be conceded that this vascular system is not in all points a counterpart of that of the blood-vessels of animals. In the leaves these proper vessels form at their origin, by means of their ramifications, a capillary network; but at their termination they do not further divide into delicate branches, to distribute, like the blood-vessels of animals, the nutritive juices to the several organs; they do not extend themselves into all parts; they leave spaces, often of considerable extent, between them, and the liquids they enclose can only reach the surrounding tissues by percolation through their walls; and consequently they are not better adapted for the distribution of nutritive material than fibres and cells, and indeed not so well fitted for that purpose as are passages and lacunæ. There is therefore a notable difference between them and the sanguiferous system of animals, the distributor of nutritive material, and one such as may be held to intimate that they do not fulfil precisely the same purpose.

We have now to inquire whether the fluid contents of the vasa propria are engaged in an act of circulation. On placing under the microscope a petal which has been rendered transparent by soaking in oil, the globules are perceived in rapid motion. This movement may be very completely seen in the living parenchyma of the stipule of *Ficus elastica*, after the removal of the epidermis from both surfaces. In this preparation the micro-

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scope shows the liquid in rapid motion, dragging the globules along with it, taking its course through the vessels and their anastomotic ramifications, and reaching their collateral branches, where it encounters other currents either pursuing the same or an opposite direction. At times the globules accumulate at some part of the vessel, and appear to block it up, until, by an effort of organic power, the obstacle is removed, and the stream resumes its ordinary course, unless it be diverted into another.

At points where the vessels are contracted, the globules may be frequently seen to overcome the incomplete barrier to their course by a leaping movement. All these phenomena can be indisputably made out; they represent a circulatory or at least an oscillatory movement, which cannot be gainsaid. The term *cyclosis* has been applied to it to distinguish it from the ordinary circulation, which conducts fluids regularly and towards a certain organ.

It has been asserted that this movement is due simply to the escape of fluid consequent on the wounding of the vessels prior to examination, or on the effects of heat, or on those of pressure or twisting to which the tissues are subjected. However, this same movement may be observed in entire and uninjured organs, and neither its constancy nor its rapidity can be explained by the occurrence of pressure. If the act of cyclosis be denied, there are equal, and indeed stronger, reasons for denying the gyration or rotation of the liquids within cells. The movements in these are sometimes so complicated that their granules, as they course along in reticulated lines through a substance of mucilaginous consistence, seem to circulate in an outstretched capillary network, either from the centre to the periphery or from the periphery towards the centre, and either to collect in a mass or to distribute themselves abroad. The transfer of granular liquids in the vasa propria is not less remarkable nor less constant than is that witnessed in the interior of cells.

The explanations offered by M. Schultz may at the same time be rejected. For our part, we are not disposed to adopt the hypothesis of repulsion and attraction among the granules of the proper juices; we do not look upon the contractility of the vessels as proved, but we cannot overlook the constant phenomenon of the transportation of the liquid contents of the vasa propria—not regularly from one point towards another, but in such a manner that the granules are driven into all the ramifications of a more or less complicated network. The force which causes their circulation also contributes, in all probability, to their frequently rapid effusion when the tissues are wounded; and this force is destroyed with the cessation of life. Not a drop

of coloured liquid escapes from the section of a plant which has been plunged for a few seconds in boiling water. [This seems, to our mind, not to prove the effects of death simply on the escape of the laticiferous fluid, but to show the coagulability of that fluid by the heat employed. In other words, is not the retention of the fluid a consequence of its coagulation by heat? —Trans.]

A very high importance should therefore be assigned to the coloured juices and to the apparatus which contains them, if this structure be found to present a uniform character in all those plants which are provided with laticiferous fluid. Let us therefore inquire whether this system possesses in its organization that character of uniformity which the general function attributed to it seems to demand. In other words, have all lactescent plants a vascular system?

We have already remarked that vasa propria are more scarce in certain parts of lactescent plants than in others, and that they are not met with at all in some of their important organs, and notably in the roots. For example, these vessels, which occur so plentifully in the stem of *Asclepias syriaca*, are infrequent in that portion of the stock which is furnished with buds, and are nearly or altogether wanting in the inferior part of this organ.

Moreover the proper vessels may become altered in character, and, so to speak, lose their primitive conformation, their continuity, their divisions, and their anastomoses.

In *Sambucus Ebulus* I have met with, in the bark and medulla, rigid, isolated, straight, and thick-walled tubes, which contained a coloured substance of considerable consistence, that became of an intense red in contact with the air, and was collected in irregular masses, grouped confusedly. These tubes were certainly more like fibres than vasa propria, nevertheless they contained special juices. I have also seen the like in *Sambucus nigra*, except that here the contained matter was less deep in colour.

In *Ferula tingitana*, and in several plants of the family Umbelliferæ, the proper juices are likewise contained in thick-walled tubes.

On approaching the roots, the reservoirs of coloured juices are found to change their nature. Thus in *Chelidonium majus* the yellow juices of the stem circulate in long and continuous vessels, whilst in the root the juices, which have acquired an orange-colour, are contained in cells of greater or less thickness, united end to end, so as to form irregular fibres. Further, in several Convolvulaceæ the coloured juices in the roots are found collected in utricles—a circumstance observed in the external

bark and in certain cortical layers interposed between the ligneous tissue of one of the Convolvuli from Brazil. The same thing may be seen in the *Convolvulus nervosus.*

In the root of *Convolvulus Turpethum* the proper juices are very abundant, and concrete into a yellow resinous substance enclosed in utricles, often considerably elongated.

This modification of form of the reservoirs of the coloured juices is not encountered only in the roots of plants, but also elsewhere. Thus, both in the external and intermediate cortical laminæ of the stem of *Glycine,* red points are seen scattered here and there on the outside of the cortical fibres, formed of cells (utricles) varying in length, more or less regular, and having their internal wall lined with a substance which appears yellow under the microscope. These utricles are disposed in such a fashion as to constitute fibres or bundles, which cannot be regarded otherwise than as analogues of vasa propria, although no exudation of coloured fluid ensues when sections of this plant are made. Certain species of Sapindaceæ also present series of coloured utricles, which, on a section of the stem, look like coloured specks, and whose organization is analogous to those of *Glycine.*

It follows, therefore, that the appellation "vessels" cannot be always given to those organs that contain coloured juices, and that the more general term *reservoirs* is better adapted to them.

This conclusion is so much the more necessary, inasmuch as, in certain instances, the utricles are not even disposed in linear series. For example, in *Piper Siriboa* the parenchyma of the external bark, as well as that of the intermediate cortical layers and the pith, has numerous reddish spots scattered throughout it, composed of cells having walls discernible with difficulty on account of their being overspread with a coloured material that is unequally diffused and analogous to that which lines the cells of *Glycine* and Sapindaceæ; but these utricles, instead of being placed in rows, and thereby approaching the characters of vessels, are accumulated in irregular masses of a more or less rounded outline.

Further, the elaborated juices of plants are met with not only enclosed within vessels and utricles, but also diffused in intercellular passages, or the natural interspaces between the cells, found especially at their angles of junction. They are likewise met with in regular lacunæ, formed by the separation of adjoining cells, and also in irregular lacunæ resulting from lacerations of the tissues. When they occupy intercellular spaces, they do not attain the same dimensions as the cells, inasmuch as they are contained in the intervals left between those portions only of the cell-walls which are not adherent throughout their whole

extent. It is this which distinguishes them from reservoirs formed by lacunæ of greater or less size, resulting from a complete severance between contiguous cells. They exhibit themselves as flexuose vessels, of very unequal diameter—an appearance due to the circumstance that the line of junction of the cell-walls, which is obscure to a certain extent, resembles a special wall, and that the passages (*meati*) follow exactly the outlines of the cells between which they occur, and exhibit enlargements at the angles of junction of the cells. Their granular liquid occasionally intrudes into the transverse lines of junction between the cells; and when this does not happen, the obscure line which bounds the reservoir inflects itself between the cells, and no vascular wall passing directly in face of or across the line of junction can be perceived—indicating thereby that the reservoir of the elaborated fluid is not a true vessel. I have observed this arrangement in several Monocotyledons—a division of plants less frequently provided with milky juices than Dicotyledons,—as for instance, in several Aroïdeæ, such as the *Pothos aurita* and the *Caladium seguinum*, where utricles occur filled with granular fluid, and where such fluid is particularly found in intercellular spaces. In certain cases, the mass of proper juices accumulated in these meati is so dense and dark, that it cannot be determined whether it is contained in a vessel or in a space formed by the separation of adjoining cell-walls; in most instances, however, it can be made out, from the indications above pointed out, that it does not occupy a vascular cavity. In *Caladium seguinum* the milky juice is less abundant than in *Pothos aurita*; and in some old leaves the section of the petioles does not give issue to any white fluid; but when young and fresh leaves are selected, a pale though an undoubted milky liquid escapes, which, after the preparation has been boiled, may be demonstrated under the microscope to be contained within cells, but particularly in the intercellular passages.

We shall, moreover, find that, though the *Colocasia odorata* has no distinct latex, a section of its petiole gives vent to a copious discharge of mucilaginous, thick, and granular juice, which is enclosed within cells as well as diffused in a characteristic manner in the intercellular spaces. This observation proves beyond cavil that a great analogy subsists between the different proper juices of plants, and that these fluids may disseminate themselves in the intercellular passages.

Let us now examine those lacunæ, of a more or less regular character, which result from the disunion of tissues.

In *Rhus typhina* (Sumach) we find reservoirs of proper juices which may perhaps retain in a considerable degree a vascular appearance, but in reality have a structure still more widely re-

moved from what we are accustomed to regard as that of vessels properly so called.

In the external layers of the bark the juices are contained in cylindrical straight channels, simple or at times having some anastomoses, which occupy the centre of the fibrous bundles of the cortex. Their diameter is so considerable that they can be detected by the naked eye; and if their surface be scraped with the edge of a sharp instrument, the fluid is seen to flow back under the pressure.

In the deeper layers of the bark, these channels of the proper juices become smaller and smaller and more ramified, but they occupy the same relative position; that is to say, they occur in the centre of the fibrous bundles.

On the internal surface of the bark they assume the form of a vascular network, with very slender ramifications and very irregular anastomoses.

These channels, however, notwithstanding their appearance, are not true vessels. On examining under the microscope the walls of such of them as occupy the centre of the bundle of primitive cortical vessels, they are seen to be formed of short cells (utricles) of a rectangular shape having thin walls, which appear to be filled with the milky liquid. These channels consequently are very analogous to the lacunæ which enclose the resinous secretions of the Coniferæ, and to those of the Cycadeæ which contain the gummy juices; and there is no more reason for regarding them as vessels with cellular walls than for giving the same appellation to the lacunæ holding the gummy and resinous secretions just referred to. The precise limit of their walls cannot be assigned. The channels of the laticiferous juices of the middle cortical layers have their walls similarly organized to those of the external lacunæ.

With respect to the network of the inner cortical layers, it is made up of cells apparently opake from the laticiferous fluid they contain; and no appreciable lacunæ can be discovered between them. Their actual existence, however, cannot be denied; for on cutting very thin sections of the tissue which contains this network, and placing them under the microscope, the reticulations, naturally of an opake white, will be found to have entirely vanished, as if the liquid to which the opacity is due had escaped, and the cells which surrounded it had become similar to the others in the tissue, and were no longer distinguishable from them.

The root of the Sumach contains lactescent juices which exude abundantly from the recently cut bark both of its larger divisions and of its most minute ramifications. On making a transverse section of a large root, the white juices are observed

to escape from a number of points disposed circularly and concentrically betwixt the cortical layers, and separated by the thickness of those layers in such a manner that these latex-carrying canals appear to be limited to the external aspect of the several cortical layers. The juices of the outer layers are somewhat yellow, at least at the period when I have examined them (between November and February), whilst those which exude from the outer aspect of the innermost layers of the bark have a pure white hue. These juices thicken and coagulate with much rapidity, and are very glutinous. They are contained in lacunæ of smaller size, less apparent and less regular in character than those met with in the stem. Their cavity is very visible in the external layers, but very much smaller and even quite inappreciable in the internal; so that these lacunæ are no longer distinguishable except by the opake speck formed by the milky juice. They are surrounded by large, short, rectangular cells filled with rounded granules of variable size. These cells are placed end to end in such a manner as to resemble wavy fibres united in a network; but these fibres form bundles less defined than those in the stem, so that the lacunæ also are less regularly circumscribed than their like in the stem, and no longer present the appearance of cylindrical canals with cellular walls; for the tissue that surrounds them is confounded with that adjacent to it. Besides these cells filled with numerous and large granules, a thin tissue is often discoverable immediately around the lacunæ, either empty or occupied with a yellowish granular matter, apparently a special secretion ["proper juice"]. Sometimes, however, the cavity of the lacunæ is immediately enveloped by a tissue of rounded granules, the thin tissue failing, at least, at parts.

If a drop of the milky liquid be placed on a piece of moistened glass, although it be partially coagulated, it is seen (at least from November to February) by the microscope to be composed of a multitude of globular granules, of all sizes, identical in appearance with those which fill the cells adjoining the lacunæ; and the impression is, that these latter contain a proper juice separated into globular particles. However, it can be shown that the grains in these cells are starch-corpuscles; for, when compressed or rolled about under the microscope, they are found to retain their globular shape, and are moreover turned blue when moistened with tincture of iodine; whereas the globules of laticiferous juice coalesce when placed between two pieces of glass and subjected to a gliding or rolling movement, and, further, instead of being coloured blue with iodine, they acquire only a yellowish tint. The tincture of iodine has often, moreover, the peculiar effect of inducing a remarkable segmentation in them,

so that these granules, particularly those of considerable magnitude, appear to be constituted of a multitude of others of extreme tenuity. When the granules are allowed to dry upon the glass slide, they at times continue distinct, and retain their globular aspect; but, on the other hand, they often collapse and spread out, uniting together to form films, excessively thin and transparent, and singularly irregular. On dropping tincture of iodine upon a slice of cortical tissue, this agent quickly removes numerous granules of the milky fluid which were contained in the lacunæ. The largest number of the cells become coloured blue as well before as after boiling, although this process causes the disappearance of the starch-corpuscles by transforming them into an amorphous mass. There are nevertheless certain cells which are not so coloured by the iodine, but contain a yellowish granular matter. The elongated cells are either empty or contain a few yellowish granules. Hence, in the Sumach, the coloured juices may be contained in cells, and are certainly met with distributed in the lacunæ; these latter are met with as well in the root as in the stem, and are sometimes regular like vessels, but at other times less distinctly defined and less uniformly cylindrical. The milky juice of *Acer platanoides* is likewise composed of rounded granules capable of coalescing and of forming regular or irregular spots when allowed to dry upon a glass slide. Lastly, there are plants, such as certain *Euphorbiæ*, the proper juices of which become extravasated, and occupy irregular lacunæ formed by the laceration of the tissues.

It follows from what has been stated, that the proper juices of plants are enclosed within reservoirs of widely different structure, which may constitute vessels, or cells, or channels (meati), or lacunæ. Those which must be looked upon as vessels are sometimes long, rigid, thick tubules, without anastomoses, or with few intercommunicating branches; whilst at other times they are thin, flexuose, and branching, with frequent inosculations, and form a more or less delicate network; they present, moreover, at times constrictions here and there, sometimes joints without septa, and at others articulations with septa. Those reservoirs which are nothing more than utricles retain in certain plants a vascular appearance, by reason of the grouping of the cells in linear series more or less marked. Further, these cells are either short or elongated, regular or irregular, thin or furnished with firm and thick walls. In other plants the cells are collected so as to form rounded masses, of very variable figure, making no approach in appearance to a series of vessels. The reservoirs which are intercellular passages (meati) present themselves in the form of slightly branching vessels, constituting now and then a sort of framework around cells. Those which

are lacunæ occur in the form of large regular vessels, but slightly anastomotic, or otherwise they constitute a network with anastomoses more or less numerous and meshes in considerable though varying number and regularity of arrangement. Lastly, the reservoirs may be nothing more than irregular cavities produced by laceration.

XXVII.—*Contributions to an Insect Fauna of the Amazon Valley.* Coleoptera : Longicornes. By H. W. Bates, Esq.

[Continued from p. 109.]

Genus Lophopœum, nov. gen.

Head, antennæ, and general shape of the body as in *Alcidion*. The thorax differs from that and the allied genera in being armed near the centre of each side with an acute tubercle or spine. The surface of the thorax is generally smooth on the disk, but is in some species slightly uneven. The elytra are subtrigonal in shape and depressed as in *Alcidion*; the shoulders are moderately prominent, and in most species a lateral carina extends thence towards the apex, but, as in *Alcidion*, this becomes very obtuse or almost obliterated in some of the species. The apex of the elytra is more or less truncated and spined, and the centro-basal ridges are always prominent, although unconnected posteriorly with a dorsal carina, the disk of the elytra being always even. The ovipositor is not exserted in the females, nor is the apical segment of the abdomen produced. The thighs are thickly and abruptly clavate, and the tarsi very moderate in length.

1. *Lophopœum carinatulum*, n. sp.

L. curtulum, minus depressum, postice rotundato-attenuatum, fusco-ferrugineum, nigro-fusco maculatum : elytris lateribus haud carinatis, carina centrobasali parum elevata nigro setosa, disco plagis tomentosis ochraceis variegato. Long. $3\frac{3}{4}$ lin.

Head rusty brown. Antennæ rust-coloured, base of each joint (from the third) paler; the basal joint somewhat evenly clavate, the upper side being convex, and the lower scarcely flexuous, but tubercled at the apex. Thorax rusty brown, varied with dingy ochreous; the lateral spine quite central and acute. Elytra less depressed than in allied species, and attenuated curvilinearly to the apex, which is briefly and obliquely truncated, and without acute angles to the truncation : there is no lateral carina, and the centro-basal ridge is only moderately raised, but is crested with black hairs; the surface is thickly punctured, except near the apex, and is without raised lines or